

Claims

[c1] What is claimed is:

1. A switched capacitor circuit comprising:
 - a positive side capacitor coupled to a first positive side node;
 - a first positive side switch element for selectively coupling the first positive side node to a second node according to a first control signal; and
 - a precharge circuit coupled to the first positive side node for precharging the first positive side node to a precharge voltage for a predetermined time when the first positive side switch element is switched off according to the first control signal, and then for charging the first positive side node to a charge voltage until the first positive side switch element is switched on according to the first control signal.

[c2] 2. The switched capacitor circuit of claim 1, wherein the precharge circuit comprises:

- a second positive side switch element coupled between the first positive side node and a third node, and having a control terminal coupled to a second control signal;
- a precharge switch element coupled between the third

node and a fourth node, and having a control terminal coupled to the first control signal; and a delay unit for generating the second control signal, wherein the second control signal is at a first voltage level for the predetermined time when the first positive side switch element is switched off according to the first control signal, and is then at a second voltage level for a remaining time that the first positive side switch element is switched off; wherein a first voltage difference between values of the first control signal in an on-state and an off-state is greater than a second voltage difference between the first voltage level and the second voltage level.

- [c3] 3. The switched capacitor circuit of claim 2, wherein the value of the first control signal in the on-state is substantially equal to the first voltage level.
- [c4] 4. The switched capacitor circuit of claim 2, further comprising:
 - a negative side capacitor coupled to a first negative side node; and
 - a first negative side switch element for selectively coupling the first negative side node to the second node according to the first control signal;
 - wherein the precharge circuit is further coupled to the first negative side node for precharging the first negative

side node to the precharge voltage for the predetermined time when the first negative side switch element is switched off according to the first control signal, and then for charging the first negative side node to the charge voltage until the first negative side switch element is switched on according to the first control signal.

- [c5] 5. The switched capacitor circuit of claim 4, wherein the precharge circuit further comprises a second negative side switch element coupled between the first negative side node and the third node, and having a control terminal coupled to the second control signal.
- [c6] 6. The switched capacitor circuit of claim 5, wherein:
 - the first positive and negative side switch elements are n-type transistors;
 - the second positive and negative side switch elements are n-type transistors;
 - the precharge switch element is a p-type transistor;
 - the second node is ground;
 - the fourth node is coupled to a constant voltage source;
 - the precharge voltage is the first voltage level minus a voltage drop across the second positive or negative side switch element; and
 - the charge voltage is the second voltage level minus the voltage drop across the second positive or negative side switch element.

- [c7] 7. The switched capacitor circuit of claim 5, wherein:
- the first positive and negative side switch elements are p-type transistors;
 - the second positive and negative side switch elements are p-type transistors;
 - the precharge switch element is a n-type transistor;
 - the second node is coupled to a constant voltage source;
 - the fourth node is ground;
 - the precharge voltage is the first voltage level plus a voltage rise across the second positive or negative side switch element; and
 - the charge voltage is the second voltage level plus the voltage rise across the second positive or negative side switch element.
- [c8] 8. The switched capacitor circuit of claim 5, further comprising a center switch element for selectively coupling the first positive side node to the first negative side node according to the first control signal.
- [c9] 9. The switched capacitor circuit of claim 1, wherein the precharge circuit comprises:
- a second positive side switch element coupled between the first positive side node and a third node, and having a control terminal coupled to a second control signal;
 - a positive side diode coupled between the first positive

side node and the third node; a precharge switch element coupled between the third node and a fourth node, and having a control terminal coupled to the first control signal; and a delay unit for generating the second control signal, wherein the second control signal is the first control signal delayed by the predetermined time; wherein the second node is coupled to a constant voltage source at a first voltage level, the fourth node is coupled to a constant voltage source at a second voltage level; and a first voltage difference between the second voltage level and the value of the second control signal in an off-state is smaller than a second voltage difference between the first voltage level and the value of the second control signal in an on-state.

- [c10] 10. The switched capacitor circuit of claim 9, wherein the value of the second control signal in the off-state is substantially equal to the first voltage level.
- [c11] 11. The switched capacitor circuit of claim 10, further comprising:
 - a negative side capacitor coupled to a first negative side node; and
 - a first negative side switch element for selectively coupling the first negative side node to the second node according to the first control signal;

wherein the precharge circuit is further coupled to the negative side node for precharging the first negative side node to the precharge voltage for the predetermined time when the first negative side switch element is switched off according to the first control signal, and then for charging the first negative side node to the charge voltage until the first negative side switch element is switched on according to the first control signal.

- [c12] 12. The switched capacitor circuit of claim 11, wherein the precharge circuit further comprises:
 - a second negative side switch element coupled between the first negative side node and the third node, and having a control terminal coupled to the second control signal; and
 - a negative side diode coupled between the first negative side node and the third node.
- [c13] 13. The switched capacitor circuit of claim 12, wherein:
 - the positive side diode is formed by a first transistor having the base and the collector, or the gate and the drain of the first transistor being shorted together; and
 - the negative side diode is formed by a second transistor having the base and the collector, or the gate and the drain of the second transistor being shorted together.
- [c14] 14. The switched capacitor circuit of claim 12, wherein:

the first positive and negative side switch elements are n-type transistors;
the second positive and negative side switch elements are n-type transistors;
the precharge switch element is a p-type transistor;
the first voltage level is ground;
the second voltage level is a constant voltage source;
the precharge voltage is the value of the second control signal in the on-state minus a first voltage drop across the second positive or negative side switch element; and
the charge voltage is the second voltage level minus a second voltage drop across the positive or negative side diode.

- [c15] 15. The switched capacitor circuit of claim 12, wherein:
- the first positive and negative side switch elements are p-type transistors;
the second positive and negative side switch elements are p-type transistors;
the precharge switch element is a n-type transistor;
the first voltage level is a constant voltage source;
the second voltage level is ground;
the precharge voltage is the value of the second control signal in the on-state plus a first voltage rise across the second positive or negative side switch element; and
the charge voltage is the second voltage level plus a sec-

ond voltage rise across the positive or negative side diode.

- [c16] 16. The switched capacitor circuit of claim 8, further comprising a center switch element for selectively coupling the first positive side node to the first negative side node according to the first control signal.
- [c17] 17. A method for controlling a switched capacitor circuit having a capacitor coupled to a first positive side node, the method comprising the following steps:
disconnecting the first positive side node from a second node to switch off the switched capacitor circuit according to a first control signal;
precharging the first positive side node to a precharge voltage for a predetermined time when the switched capacitor circuit is switched off according to the first control signal; and then
charging the first positive side node to a charge voltage until the switched capacitor circuit is switched on according to the first control signal.
- [c18] 18. The method of claim 17, wherein the precharging and charging steps further comprise:
coupling the first positive side node to a third node according to a second control signal;
coupling the third node to a fourth node according to

the first control signal; and generating the second control signal to be at a first voltage level for the predetermined time when the switched capacitor circuit is switched off according to the first control signal, and then to be at a second voltage level for a remaining time while the switched capacitor circuit is switched off; wherein a first voltage difference between values of the first control signal in an on-state and an off-state is greater than a second voltage difference between the first voltage level and the second voltage level.

- [c19] 19. The method of claim 18, wherein the value of the first control signal in the on-state is substantially equal to the first voltage level.
- [c20] 20. The method of claim 18, wherein the switched capacitor circuit further has a negative side capacitor coupled to a first negative side node, the method further comprising the following steps:
 - disconnecting the first negative side node from the second node when the switched capacitor circuit is switched off according to a first control signal;
 - precharging the first negative side nodes to the precharge voltage for the predetermined time when the switched capacitor circuit is switched off according to the first control signal; and then

charging the first negative side node to the charge voltage until the switched capacitor circuit is switched on according to the first control signal.

- [c21] 21. The method of claim 20, wherein the precharging and charging steps further comprise coupling the first negative side node to the third node according to the second control signal.
- [c22] 22. The method of claim 20, further comprising selectively coupling the first positive side node to the first negative side node{node B} according to the first control signal.
- [c23] 23. The method of claim 17, wherein the precharging and charging steps further comprise:
 - coupling the first positive node to a third node according to the second control signal;
 - providing a diode coupled between the first positive side node and the third node;
 - coupling the third node to a fourth node according to the first control signal; and
 - generating the second control signal; wherein the second control signal is the first control signal delayed by the predetermined time;
 - wherein the second node is coupled to a constant voltage source at a first voltage level, the fourth node is

coupled to a constant voltage source at a second voltage level; and a first voltage difference between the second voltage level and the value of the second control signal in an off-state is smaller than a second voltage difference between the first voltage level and the value of the second control signal in an on-state.

- [c24] 24. The method of claim 23, wherein the value of the second control signal in the off-state is substantially equal to the first voltage level.
- [c25] 25. The method of claim 23, wherein the switched capacitor circuit further has a negative side capacitor coupled to a first negative side node, the method further comprising the following steps:
disconnecting the first negative side node from the second node when the switched capacitor circuit is switched off according to a first control signal;
precharging the first negative side nodes to the precharge voltage for the predetermined time when the switched capacitor circuit is switched off according to the first control signal; and then
charging the first negative side node to the charge voltage until the switched capacitor circuit is switched on according to the first control signal.
- [c26] 26. The method of claim 25, wherein the precharging

and charging steps further comprise:
coupling the first negative side node to the third node
according to the second control signal; and
providing a negative side diode coupled between the
first negative side node and the third node.

- [c27] 27. The method of claim 26, further comprising:
forming the positive side diode using a first transistor
having the base and the collector, or the gate and the
drain of the first transistor being shorted together; and
forming the negative side diode using a second transis-
tor having the base and the collector, or the gate and the
drain of the second transistor being shorted together.
- [c28] 28. The method of claim 25, further comprising selec-
tively coupling the first positive side node{node A} to the
first negative side node{node B} according to the first
control signal.